Statistical analysis of RHESSI GRB database

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Summary. — The Gamma-ray burst (GRB) database based on the data by the RHESSI satellite provides a unique and homogeneous database for future analyses. Here we present preliminary results on the duration and hardness ratio distributions for a sample of 228 GRBs observed with RHESSI.

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1. – Introduction

The Ramaty High-Energy Solar Spectroscopic Imager (RHESSI) is a NASA Small Explorer satellite designed to study hard X-rays and gamma-rays from solar flares [1]. It consists mainly of an imaging tube and a spectrometer. The spectrometer consists of nine germanium detectors [2]. They are only lightly shielded, thus making RHESSI also very useful to detect non-solar photons from any direction. The energy range sensitive for GRB detection extends from about 50 keV up to 20 MeV depending on the incoming direction. Energy and time resolutions are excellent for time resolved spectroscopy: $\Delta E = 3$ keV (at 1000 keV), $t = 1$ μs. The effective area for near axis direction of incoming photons reaches up to 200 cm^2 at 200 keV. With a field of view of about half of the sky, RHESSI observes about one gamma-ray burst per week (see also `http://grb.web.psi.ch`).

2. – Duration distribution, hardness ratio vs. duration

Totally observed 228 gamma-ray bursts from Feb. 2002 to Jan. 2006 were used. Originally it was found (results from BATSE, Konus-Wind etc. instruments [3, 4]) that

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there exist at least two subclasses of GRBs; the short one with T_{90} approximately less than 2 s and the long one with T_{90} approximately more than 2 s, where T_{90} is the time interval during which the cumulative counts increase from 5% to 95% above background. As one can see, we obtained distribution with two maxima: about 0.2 s and 15 s. Some articles point to existence of the three subclasses of GRBs [5]. We have investigated this in the RHESSI database. We fitted one-, two- and three-lognormal functions (fig. 1) and then we used statistical χ^2-test to evaluate these fits. This procedure was successfully used on BATSE Catalog (see [6]). From the statistical point of view a single lognormal does not fit the observed distribution. The assumption that there is only one subclass is rejected on a greater than 99.99% significance level. For the best fitting with the two Gaussian functions we obtained significance level = 15.9%. For the best fitting with the three Gaussian functions we obtained significance level = 16.4%. Hence, RHESSI data can be interpreted by at least two GRB's subgroups. A further result is that the short bursts give about 15% of all 228 events observed by RHESSI.

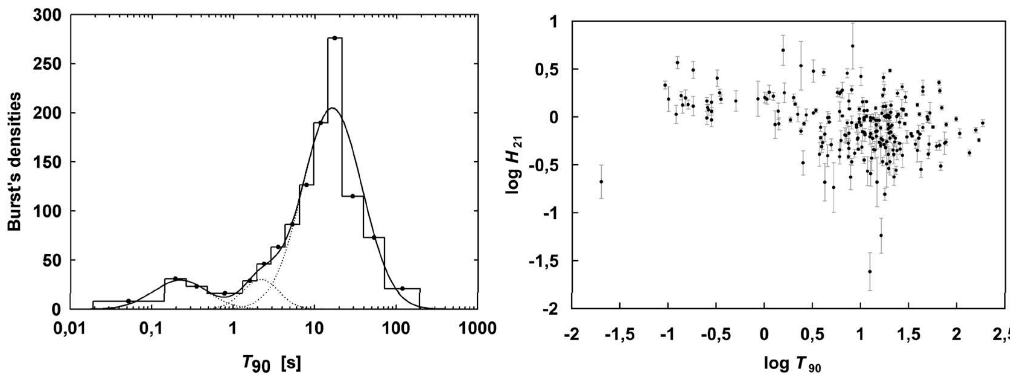

Fig. 1. – (Left) Distribution of durations of GRBs with the best 3-lognormal fit. (Right) Hardness ratio H_{21} vs. duration T_{90}.

The hardness ratio is defined as the ratio of two fluences F in two different energy bands integrated over the time interval T_{90}. Specifically we have three energy bands: 25 - 120 keV, 120 - 400 keV and 400 - 1500 keV, and corresponding fluences therein: F_1, F_2 and F_3. In fig. 1 we show the hardness-ratio $H_{21} = F_2/F_1$ vs. T_{90} duration for our RHESSI dataset. We confirm the results of BATSE ([3]) that on average short GRBs are harder. We plan to use some cluster analysis to exactly decide the number of subgroups.

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